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Concurrent associations between maternal behaviours and infant communication within a cohort of women and their infants experiencing adversity.

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Abstract

Purpose: Evidence suggests that children living in adversity are at greater risk of poorer language than their peers with the quality of parental interactions potentially mediating this association. Studies typically measure the mediatory impact of generic interaction styles making it difficult to discern which particular aspects of the interaction are facilitating language. This study aims to bridge this gap by identifying specific maternal behaviours associated with concurrent infant communication, in a cohort of 12-month old infants and their mothers experiencing adversity.

Method: 249 mother-infant free-play videos were collected from women experiencing adversity in Victoria and Tasmania, Australia. From those videos, specific maternal behaviours, infant communication acts and the interaction quality were coded.

Result: Maternal verbal imitations uniquely predicted concurrent use of infant vocalisations, total words and unique words. Furthermore, the more fluent and connected the mother-infant dyad, the stronger the association between imitations and all three infant measures.

Conclusion: Frequent use of maternal imitations, within highly connected mother-infant dyads, may help mediate the impact of adversity on early communication. This information is important for early years professionals working with at-risk populations in augmenting current knowledge of risk and protective factors related to early language.

Key words: Language development, responsiveness, parents

Introduction

Although there is significant variability in early language trajectories (Zambrana, Pons, Eadie, & Ystrom, 2014), children living in households experiencing adversity are consistently at

greater risk of poorer language throughout childhood (Hart & Risley, 1995; Law, McBean, & Rush, 2011). There are several types of adversity related to language. Socioeconomic status (SES) measures including lower household income, occupation and educational achievement have been strongly linked with poorer language (Hart & Risley, 1995; Perkins, Finegood, & Swain, 2013). However, other measures of adversity have also been unfavourably related, for example, teen parenthood (Keown, Woodward, & Field, 2001), ethnic minority status (Shimpi, Fedewa, & Hans, 2012) and parental mental health difficulties (Stein et al., 2008).

Within the literature, estimated rates of language difficulties in cohorts of children experiencing adversity have been found to range from 30.5% (ages 3;0-4;11 years) (Ryan, Gibbon, & O'Shea, 2016), to 40% (5;0-12;0 years) (Law et al., 2011) up to 56% (3;0-4;3 years) (Locke, Ginsborg, & Peers, 2002). Moreover, when compared to other child outcomes, language development has been found to be particularly vulnerable to the impact of adversity (Duncan & Brooks-Gunn, 2000). As poor early language is associated with a variety of longer-term issues, including literacy difficulties (Zubrick, Taylor, & Christensen, 2015) and increased risk of antisocial behaviour (Snow & Powell, 2008) language difficulties are a global concern (Zubrick et al., 2015).

Arriaga, Fenson, Cronan and Pethick (1998) compared the language skills of toddlers from low-income families (*n*=103) to middle-income matched controls. They used the MacArthur Communicative Development Inventory (CDI), Words and Sentences (Fenson et al., 1994) to evaluate three main language areas: vocabulary production, combining words and sentence complexity. The low-income group scored significantly lower on all language areas, with a shift towards the lower end for the entire distribution of scores. More recently, Roy, Chiat and Dodd (2014) recruited low-SES (*n*=208) and mid-high SES (*n*=168) preschool children from

early years settings across London. They collected standard measures of expressive and receptive language using the UK version of the Clinical Evaluation of Language Fundamental-Preschool-2 (CELF-2^{UK}) (Semel, Wiig, & Secord, 2006). They also measured basic language skills, for example, the ability to repeat words and sentences and learn new words. The materials and procedures used in these basic language measures do not typically rely upon a child's prior experience, theoretically minimising the bias often attached to standardised tests (Lidz & Pena, 2009). Language repetition, for instance, was thought free from higher-level linguistic input, thus a similar performance was expected from children of all SES backgrounds. The low-SES sample scored consistently below the population mean on all standardised test measures; the mid-high SES group conversely scored consistently above the mean. An unexpected finding was that the low-SES group were also significantly poorer on basic language measures, for example, repeating words and sentences. These findings highlight that the everyday language environments of children experiencing adversity are less effective at facilitating basic language, not just those skills requiring higher level input.

An emerging body of neurobiological research supports the association between language outcomes and adversity frequently found in the literature. Noble, Norman and Farah (2005) assessed the cognitive skills of 24 middle and 26 lower SES preschool children across five neurocognitive domains. They found only two domains were highly predicted by SES: the perisylvian/language and the pre-frontal/executive system. More recently, Jednoróg et al. (2012) used magnetic resonance imaging (MRI) to explore differences in the neural structures of 23, healthy ten-year old children from varying SES backgrounds. They also administered a battery of standardised tests measuring literacy, verbal and non-verbal skills. Not only did the researchers find positive correlations between SES and literacy, and SES and verbal skills, they also saw widespread differences in the brain anatomy of the children that were associated

with SES measures on the MRI scans. Furthermore, they found no significant associations between SES and any non-verbal intelligence quotient (IQ) measure. The findings suggest that the physiology of areas of the child's brain related to language is sensitive to different environments (Perkins et al., 2013). Furthermore, various studies have found that these disparities are not confined to those children living in extreme poverty, but are apparent across the lower end of the socioeconomic continuum (Hart & Risley, 1995; Jednoróg et al., 2012).

Several models have been proffered to explain how living in adverse conditions is realised in child outcomes. The Learning Experiences Model (Brooks-Gunn & Duncan, 1997), for example, suggests that limited educational experiences within the home directly reduce a child's opportunity to develop skills, thus reducing overall outcomes. Whereas The Family Stress Model (Conger, Conger, & Elder, 1997) suggests that poorer outcomes indirectly result from distant, unsupportive parenting due to the stress of economic pressures. Both explanations have been shown to be valid in large-scale studies. Yeung, Linver and Brooks-Gunn (2002) found that maternal well-being, provision of cognitively stimulating activities and parenting style mediated the association between family income and child outcomes (n=753). A later study concluded similar results. Lugo-Gil and Tamis-LeMonda (2008) conducted a large study of mothers and children (n=2,089) analysing the impact of family resources on child outcomes at 14, 24 and 36 months of age. Parenting quality mediated the association between resources and child outcomes at all ages. It appears that economic and social adversity put children at risk of poorer outcomes but they do not directly result in poorer outcomes: the risks are cumulative. A child experiencing adversity but exposed to frequent, facilitative parental exchanges may have better language than a child in the same environment who is deprived of such interactions.

With regards to child language specifically, it appears that particular parental language characteristics may mediate the impact of adversity; for example, characteristics of responsive (Baydar & Akcinar, 2015; Keown et al., 2001; Shimpi et al., 2012) and less intrusive parenting (Keown et al., 2001) are consistently associated with more advanced language skills in cohorts experiencing adversity. Responsiveness is defined as the provision of expeditious, semantically contingent and appropriate responses to what a child has said or done (Tamis-LeMonda, Bornstein, & Baumwell, 2001). Conversely, intrusiveness refers to parental behaviours not contingent on child behaviours and which aim to commandeer the activity (Ipsa et al., 2004). Both responsive and less intrusive parenting are inclusive of numerous and varied behaviours in the current literature making it difficult to discern specific aspects of the interaction facilitating language acquisition (Hirsh-Pasek et al., 2015). Some studies have measured the association between child language and discrete maternal behaviours associated with responsiveness or intrusion, for example, responsive verbal imitations (Masur, Flynn, & Eichorst, 2005; Tamis-LeMonda et al., 2001), responsive questions (Levickis, Reilly, Girolametto, Ukoumunne, & Wake, 2014) and intrusive directives (Masur et al., 2005). However, these studies have not focussed on cohorts experiencing adversity where such behaviours may play a more pivotal role in early language trajectories (Baydar & Akcinar, 2015).

The way a mother interacts with her child is neither unidirectional nor discrete. Many studies in this field only measure the impact of the mother's language on the child's (Lloyd and Masur, 2014), yet communicative behaviours do not occur in isolation. Behaviours are 'socially shaped' and will vary from moment to moment in response to the partner (Gros-Louis, West, & King, 2014). Furthermore, this shaping occurs for both mothers and infants

alike (Sameroff & MacKenzie, 2003). Gros-Louis, West and King (2014) discovered that mothers responded significantly more to infant vocalisations directed to themselves, rather than object-directed vocalisations (*n*=12). Lloyd and Masur (2014) also found that social initiations by 13-month old infants elicited more maternal responsive behaviours compared to object-directed initiatives (*n*=26). A cyclical effect may be at play; a more communicative child may be rewarded with more frequent, facilitative maternal input. Mothers may also initiate exchanges that occur more regularly with sociable children, deriving increased satisfaction from the interactions (Alston & St James-Roberts, 2005). In turn, engaged mothers may be more interesting for children thus further propagating the cycle. These infants may therefore benefit from cumulative episodes of sustained, joint attention. Theoretically, joint attention allows capacity for word learning as the child does not have to use additional resources to shift attention to understand the adult referent (Shimpi & Huttenlocher, 2007; Tomasello and Todd, 1983). Consequently, it may not only be easier for a mother to provide facilitative linguistic input within a fluent and connected interaction, but the benefits of this input may be augmented when introduced in periods of shared, sustained attention.

One recent study explored the contribution of sensitive parenting and maternal words per minute to child language in low-income families (Hirsh-Pasek et al., 2015). However, this study also accounted for the dyadic nature of language by measuring the fluency and connectedness of the mother-child interaction. The rating scale from the Communication Foundation Rating Items technical report was used to measure fluency and connectedness (see Adamson, Bakeman, Deckner, & Nelson, 2012). The scale was designed to encapsulate how communication partners scaffold and maintain their dialogue using verbal and non-verbal turns. Of all the predictors in the study, fluency and connectedness was found to be the strongest predictor of language at child age two years. This study demonstrates the value of

accounting for the reciprocity within early mother-child interactions (Sameroff & Mackenzie, 2003), as well as measuring other factors known to shape early language.

There are two main gaps in the current literature. Firstly, studies with cohorts experiencing adversity do not report on specific, modifiable maternal behaviours associated with child language outcomes so conducting trials of discrete behaviours in assessment or intervention remains problematic. Secondly, studies frequently fail to account for how maternal behaviours are influenced by the fluency and connectedness of the mother-child interaction. Furthermore, studies which have explored the mother-child dyad (Hirsh-Pasek et al., 2015) have not comprised infants as young as 12 months of age. This study aims to bridge these gaps by identifying specific, modifiable responsive and intrusive maternal behaviours, associated with infant communication skills in a large cohort of mothers and infants experiencing adversity. It will also account for how these maternal linguistic behaviours are incorporated in to mother-infant dyads by accounting for the fluency and connectedness of the interaction (Hirsh-Pasek et al., 2015). The findings will be important in understanding more about the role maternal behaviours and interaction quality play in early infant communication.

Study aims

1. To explore the associations between specific maternal behaviours and concurrent infant communication skills in a large cohort of women and their infants experiencing adversity;
2. To understand the extent to which significant maternal-infant associations are moderated by the fluency and connectedness of the interaction.

Method

Study design and participants

This study is nested within the right@home trial, a longitudinal randomised controlled trial (RCT) being conducted at the Murdoch Childrens Research Institute (MCRI). Right@home measures the effectiveness of sustained, nurse home visiting (SNHV) offered to women experiencing adversity from pregnancy to child age two years. The right@home trial began in January 2013 and is scheduled to conclude in December 2019. This study is based within the control arm so does not report on right@home outcomes.

Recruitment to right@home took place from April 2013 to September 2014 across 11 maternity hospitals in Victoria and Tasmania, Australia. Indicators of adversity were two or more of the following: current smoking, young pregnancy (<23 years), no support during pregnancy, poor/fair/good health (versus very good/excellent general health), anxious mood, not finishing high school, not having a household income, a long-term illness, not living with another adult and/or never having a job. Women were excluded if they had limited spoken English or critical events occurred during pregnancy or birth. In total, 722 participants were recruited to the trial. Following an initial baseline assessment at home, participants were randomised to intervention and control arms. Three-hundred and fifty-nine women were randomised to the control arm, with 311 of those women completing face-to-face assessment when their child turned 12 months of age (86.6%). Participants from the control arm who consented to videoing at that assessment were enrolled in this study (*n*=249, 80.1%). Of note, 16 of the original 265 videos had to be excluded from analysis due to technical reasons. Baseline characteristics of the women and infants included in the study are detailed in Table I.

Ethics

Ethical approval has been gained from the Royal Children's Hospital (RCH) (RCH HREC

Number: 32296A) for the right@home study. Specific approval was also gained from the individual sites taking part in the study. Study protocol includes consent to collect and examine videos of mother-child interactions. Additionally, ethical approval has been gained from The University of Melbourne, Human Research Ethics Committee for this study (Ethics Application ID: 1545222.1).

Procedures

At infant age 12-months, right@home researchers conducted a home-based assessment with all participants. Mothers and their infants were video recorded on an iPad during eight minutes of free-play. Women were provided with identical, age-appropriate toys including a playground set with toy figurines and plastic construction blocks allowing for different types of play. The data for this current study come from analysis of five minutes or 300 seconds (s) of footage in the middle of each video (M=297s, SD 13.58s, range 208-301s). Of note, five minutes of footage has been used to measure maternal responsiveness and sensitivity in other research studies (Alston & St James-Roberts, 2005; Lloyd & Masur, 2014).

Measures

Maternal behaviours

Four maternal responsive behaviours (imitations, responsive labels, responsive 'wh' questions and responsive yes/no questions) and three maternal intrusive behaviours (prohibitions, successful redirectives and unsuccessful redirectives) were selected as predictor variables. These behaviours were chosen following a comprehensive literature search with noteworthy studies documented in Table II. Detailed descriptions of each maternal behaviour can also be found in Table II. Behaviours were coded using Observer® XT software (Noldus, 2008) by the first author for the five minutes in the middle of the videos. All maternal behaviours were

mutually exclusive, but not exhaustive. In line with similar studies, behaviours were only counted as responsive if the mother acted within five seconds of the child's preceding action (Baumwell, Tamis-LeMonda, & Bornstein, 1997). Intrusive behaviours could occur at any time.

Infant communication behaviours

Although infant communication behaviours were measured during spontaneous mother-infant free-play videos, eleven tests/screens containing assessment of early language and communication were initially reviewed to help generate suitable measures. Various behaviours were then piloted on ten videos. To meet inclusion criteria for the final coding scheme, measures needed to be age-appropriate, frequent and easily observable. Infant communication behaviours coded were: showing/giving mother an object, looking to mother's face, pointing, pretend play, vocalisations and words. Four additional behaviours were also coded but discontinued as consistent inter-rater reliability could not be met (infant reaching for an object, responding to look, responding to name and following pointing). See Table III for detailed descriptions of infant behaviours. Behaviours were coded using Observer® XT software (Noldus, 2008) by the first author for the five minutes in the middle of the videos. The behaviours were neither exhaustive nor mutually exclusive, for example, an infant could vocalise whilst showing their mother an item which would have been coded as two concurrent behaviours.

Fluency and connectedness

The Communication Foundation Rating Items technical report was used to assign fluency and connectedness ratings (see Adamson et al., 2012; Hirsh-Pasek et al., 2015). To measure the fluency and connectedness of the interaction, the same five minutes of footage was re-

watched and rated from one to seven. The rating scale measured how the mother and infant structured and maintained their dialogue using verbal and non-verbal turns. See Table IV for anchor points for the rating scale.

Inter-rater reliability

For maternal behaviours, infant behaviours and fluency and connectedness, inter-rater reliability was conducted on 10% of the sample at the beginning, middle and end of the coding period (*n*=75 videos in total). Videos were randomly selected and coded by a second coder (fifth author). Intraclass correlation coefficients (ICC) were deemed suitable to assess inter-rater reliability for the consistency of maternal and infant behaviours (McGraw & Wong, 1996). As reported by Cicchetti (1994), reliability was excellent for maternal behaviours with the following coefficients: imitations (0.95), labels (0.97), responsive questions (0.94), yes/no questions (0.92), prohibitions (1.0), successful redirectives (0.92) and unsuccessful redirectives (0.96). Reliability was also excellent for infant behaviours with the following coefficients: looks to face (1.0), words (0.96), vocalisations (0.96) and give/show (0.80). There were no instances or pointing or pretend play in the inter-rated infant videos hence coefficients are unavailable for either measure. The kappa statistic was used to gauge agreement between the raters for the fluency and connectedness measure. Agreement was met when both raters achieved the same score or one score apart. According to Landis and Koch (1977), substantial agreement was met between the raters (k=0.80). For all videos, disagreements were discussed with the final decision being made by the first author.

Statistical analysis

To address the first research aim, a correlation matrix of the predictor and outcome variables was initially generated. As assumptions of linearity were met, linear regression models were

then fitted. Only significant maternal and infant associations were explored in the regression models. The initial linear regression models individually tested maternal behaviours as predictors for discrete infant outcomes. Analyses were then extended to adjust for all potential confounders (infant age at assessment, gender, birth order, main language and family history of language and literacy difficulties). Although not finishing high school was one inclusion criterion for the right@home study, maternal education was also included as a confounder. Both predictor and outcome variables were converted to z scores for the regression models in order to calculate relative effects.

The next analysis then tested the adjusted regression models using fluency and connectedness as a moderator. Simple slopes were computed to gauge the amount of change in each significant infant outcome with one unit change in the predictor variable, whilst keeping the moderator (fluency and connectedness) constant at different values between the lowest (low quality interaction) and highest rating (high quality interaction).

Result

When compared to women recruited at baseline, women in the current study were more likely to be older ($t(357) = -2.61$, $p = 0.01$), employed ($x^2(1) = 13.47$, $p = 0.00$) with their main source of household income generated from full or part time work ($x^2(4) = 17.23$, $p = 0.00$). The infant was also more likely to be younger at the assessment ($t(309) = 3.57$, $p = 0.00$). There were no differences between the women regarding education levels, mental health status, socioeconomic index for areas (SEIFA) scores, home language or country of birth.

Descriptive statistics

All results are presented in rate of behaviours per minute to account for minor variations in video length. Regarding specific responsive behaviours, 85% of mothers used labelling (M = 1.21, SD = 1.10, range 0-6), 78% used responsive questions (M = 0.65, SD = 0.64, range 0-3.2), 70% used yes/no questions (M = 0.48, SD = 0.57, range 0-3.2) and 60% used imitations (M = 0.40, SD = 0.46, range 0-2.2). Regarding specific intrusive behaviours, 82% of mothers used successful redirectives (M = 0.55, SD = 0.47, range 0-2.2), 62% used unsuccessful redirectives (M = 0.58, SD = 0.92 range 0-5.6) and 43% used prohibitions (M = 0.34, SD = 0.71, range 0-6.2).

As expected for infants of this age, pointing and pretend play were the least observed communication behaviours with only 5% of infants pointing (M = 0.02, SD = 0.09, range 0-.80) and 10% demonstrating pretend play (M = 0.27, SD = 1.1, range 0-10). A third of infants (32%) were showing/giving their mother objects (M = 0.20, SD = 0.42, range 0-2.8) and half (50%) were using words (M = 0.29, SD = 0.45, range 0-3). The vast majority of infants were looking to their mother's face (85%) (M = 0.98, SD = 0.97, range 0-4.8) and vocalising (93%) (M = 1.83, SD = 0.98, range 0-4.01).

Due to the young age of the children, the maximum fluency and connectedness rating obtained was five, with a minimum rating of one (M = 2.82, SD = 0.96).

Maternal and infant communication behaviours

Table V presents a correlation matrix of all maternal and infant variables. Only seven correlations were statistically significant, varying in magnitude from small (0.1), moderate (0.3) to large effect sizes (0.5) (Cohen, 1988). Imitations, responsive questions and labels were found to be significantly correlated with looks to face (0.22, 0.18 and 0.11 respectively).

Imitations were also significantly correlated with vocalisations (0.27), total words (0.56), unique words (0.43) and give/shows (0.24). These seven significant associations were then explored in linear regression models. Table VI presents the fully adjusted associations between significant maternal behaviours and infant communication. In the fully adjusted models only maternal imitations significantly predicted any infant behaviours. Imitations predicted greater use of vocalisations (coefficient 0.20, 95% CI [0.07, 0.33], p = 0.00), a greater total number of words (coefficient 0.59, 95% CI [0.37, 0.82], p = 0.00) and a greater number of unique words (coefficient 0.57, 95% CI [0.36, 0.77], p = 0.00).

Maternal-infant behaviour associations, fluency and connectedness

The associations between imitations and vocalisations, total words and unique words were explored using fluency and connectedness as a moderator. When fluency and connectedness was held at zero, there was no main effect of imitations on any infant outcome: vocalisations ($F(7,184) = 4.42$, $p = 0.68$), total words ($F(9,184) = 7.53$, $p = 0.58$) or unique words ($F(9,182) = 6.11$, $p = 0.50$). When imitations were held at zero, there was a main effect of fluency and connectedness on total words ($F(9,184) = 7.53$, $p = 0.00$) and unique words ($F(9,184) = 6.11$, $p = 0.02$), but not vocalisations ($F(7,184) = 4.42$, $p = 0.26$). For vocalisations ($F(9,182) = 4.42$, $p = 0.05$) and total words ($F(9,182) = 7.53$, $p = 0.01$) there was a significant interaction between imitations and fluency and connectedness. A significant interaction was not found for unique words ($F(9,183) = 6.09$, $p > 0.05$) but as the interaction quality would also theoretically moderate this association simple slopes were still computed (Kirkwood & Sterne, 2005). Simple slopes for imitations and both total words and unique words were significant for all values of fluency and connectedness, except when fluency and connectedness was held at one. Simple slopes for imitations and vocalisations were significant except when fluency and connectedness was held at one or two. A positive linear relationship

was found between each maternal and infant behaviour and the fluency and connectedness of the interaction. See Table VII for the three-way interaction between maternal behaviours, predicted infant communication and fluency and connectedness. See *Figure 1* for simple slopes depicting the amount of change in each infant outcome with one unit change in the predictor variable, whilst keeping fluency and connectedness constant at different values between one and five.

Discussion

This study aimed to identify specific maternal behaviours associated with concurrent infant communication skills at 12 months of age in a cohort of women and their infants experiencing adversity. It also aimed to explore if the fluency and connectedness of the interaction moderated the associations between the mother and infant variables. We found that maternal imitations were associated with all three concurrent infant verbal skills: vocalisations, total words and unique words. This is the first study to replicate these results in a large cohort of mother-infant dyads experiencing adversity in Australia. This study also expands upon previous findings by demonstrating that these associations do not occur in isolation but are moderated by the quality of the mother-infant interaction. In the current study, the more fluent and connected the mother-infant dyad, the stronger the association between maternal imitations and all infant verbal outcomes.

Previous studies, not comprising mothers and infants experiencing adversity, have documented the association between maternal imitations and early child language (Levickis et al., 2014; Masur et al., 2005; Tamis-LeMonda et al., 2001). Maternal imitations provide the child with immediate feedback that their verbal sounds have meaning to another person encouraging the transition from pre-intentional to intentional verbal communication.

Imitations also shape and encourage early words by promptly reinforcing the adult target (Tamis-LeMonda et al., 2001). These imitations can also then be echoed by the child helping further shape syllabic, speech-like sounds (Bloom, Russell, & Wassenberg, 1987). Furthermore, better child language outcomes have been found in studies where there is a high level of reciprocity within the mother-child dynamic (Tomasello & Todd, 1983). What imitations perhaps achieve, over and above other responsive behaviours at this age, is in engendering simple, verbal reciprocity between the mother and infant. The cause-and-effect nature of vocalisation, immediately followed by imitation, may be entertaining for infants of this age (Lanza & Flahive, 2008) consequently encouraging talkativeness.

Mother-child fluency and connectedness has been associated with child vocabulary in 24-month-old children (Hirsh-Pasek et al., 2015). This is the first study to explore the role of fluency and connectedness in mother-child associations with younger infants. In theory, a fluent and connected interaction underpins mother and infant responsivity and sustained joint attention. A fluent, connected interaction may also support early pragmatic skills, for example, development of a 'speak-listen' conversational structure (Black & Logan, 1995). A child may potentially be more receptive to novel word learning in their role as a 'listener'. Pragmatic skills, joint attention and maternal imitations are all associated with child language development (Tamis-LeMonda, Kuchirko, & Song, 2014). An amassed benefit may therefore occur when all three coexist together. Potentially early vocabulary acquisition is optimised when mothers reinforce words via imitation within a co-constructed 'speak-listen' dynamic (Hirsh-Pasek et al., 2015).

In this study, both maternal imitations and interaction quality were important in promoting early linguistic advances. Since children play a role in shaping their own communicative

milieu, sociable, talkative infants may provide more cues to scaffold interactions and prompt maternal imitations (Keown et al., 2001; Raviv, Kessenich, & Morrison, 2004). Conceivably the opposite could occur; opportunities to stimulate language may be scarcer with a less verbal child (van Balkom, Verhoeven, & van Weerdenburg, 2010), for instance, children using fewer vocalisations provide their mothers with limited chances for imitation (Tamis-LeMonda et al., 2001). Alston and St James-Roberts (2005) found low levels of infant babbling, plus less maternal interaction, sustained poorer interactions between mothers and infants. This is noteworthy when considering infants at greater risk of poorer language, for example, those living in adversity. Both mothers and infants could unconsciously perpetuate an environment less conducive to language learning (Alston & St James-Roberts, 2005).

Previous studies have found that higher-SES parents use their language more resourcefully when presented with challenging behaviours, for example, creatively redirecting the child to a novel task (Hart & Risley, 1995). This may hold true for children with more challenging communicative behaviours whereby some parents may be better equipped at compensating for a child with limited language. Feasibly children and mothers experiencing adversity may be especially disadvantaged. The mother and infant may unintentionally create a less conducive language environment *and* have fewer tools to repair conversational breakdown. Thus, the import of maternal imitations and quality interactions could be particularly essential within this cohort where maternal responsiveness may play a larger role in child outcomes than for children not experiencing adversity (Baydar & Akcinar, 2015).

Other maternal responsive behaviours and all intrusive behaviours were largely unrelated to concurrent infant communication. One explanation may be that intrusive behaviours have minimal impact on language skills in infancy (Baumwell et al., 1997) but a latent effect may

be realised in later child language following sustained exposure to intrusive behaviours. The benefit of other responsive behaviours (for example, responsive questions) may also be more apparent for older toddlers as their understanding and use of language develops (Lanza & Flahive, 2008). Exploration of maternal behaviours in relation to later child language within this cohort will be important in understanding concurrent and longitudinal variances.

Strengths and limitations

A key strength of this study was the relatively large cohort of women experiencing adversity. This was complemented by informal, naturalistic measurement of infant communication. Informal assessment may be more representative of an infant's holistic communication skills (Tamis-LeMonda & Bornstein, 1994) and avoid the cultural and linguistic bias often attached to standardised tests (Lidz & Pena, 2009). There were also several study limitations. Although rate of maternal behaviours was calculated, the amount and diversity of maternal language was not controlled for in the analysis. Additionally, toy-play may not have represented the most typical, nor frequent, interaction in a child's day (Flynn & Masur, 2007). Furthermore, the actual process of videoing using unfamiliar toys may have been limiting, particularly for minority groups (Ispa et al., 2004).

Implications

As maternal behaviours are potentially mutable, our findings suggest that increasing the frequency of maternal imitations in infancy may scaffold early communication development in cohorts experiencing adversity. Additionally, early language acquisition could be optimised when maternal imitations are introduced in fluent, connected mother-infant interactions. This information is important for early years professionals (for example, maternal child health nurses, early childhood educationalists and paediatric speech pathologists) working with at-

risk populations in augmenting current knowledge of risk and protective factors related to early language. The information can also be utilised in intervention planning for infants presenting with poorer language. Promoting reciprocal mother-infant interactions *and* frequent use of maternal imitations may be a more effective therapeutic approach than encouraging discrete language-facilitation strategies.

Conclusion

This study aimed to identify concurrent associations between maternal behaviours and infant communication within a large cohort of mothers and their infants experiencing adversity. We found that at 12 months of age, maternal imitations were significantly associated with concurrent infant vocalisations, total words and unique words. Furthermore, the more fluent and connected the mother-infant interaction, the stronger each association. Frequent use of maternal imitations, within highly connected mother-infant dyads, may help mediate the impact of adversity on infant language outcomes.

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Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writings of the paper.

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Table I: Baseline characteristics of mothers and infants in the right@home control group and in the current study

	Control group (*n*= 359)	**Current study (*n*=249)**
Mean maternal age at baseline: years; months (SD)	27.8 (6.4)	28.4 (6.2)
Mean infant age at 12-month assessment: months (SD)	12.2 (1.0)	12.1 (1.0)
Maternal mental health	**(m, SD)**	**(m, SD)**
DASS[1] Anxiety total[2]	3.4 (3.3)	3.4 (3.2)
DASS Depression total[3]	2.9 (3.3)	2.7 (2.8)
DASS Stress total[4]	5.4 (4.0)	5.4 (3.9)
Maternal characteristics	**n (%)**	**n (%)**
Teen parenthood	39 (10.9)	18 (7.2)
Highest level of education		
Did not complete high school	83 (23.1)	56 (22.5)
Completed high school	19 (5.3)	14 (5.6)
Vocational training/diploma	222 (61.8)	131 (52.6)
Completed bachelor degree or higher	35 (9.7)	26 (10.4)
Currently employed	120 (33.4)	95 (38.2)
Marital status		
Single / Not living with partner	92 (25.6)	61 (24.5)
Married / Living with partner, not married	260 (72.4)	183 (73.5)
Separated / Divorced	7 (1.9)	5 (2.0)
Language other than English	33 (9.2)	25 (10.0)
Born overseas	62 (17.3)	45 (18.1)

	Control group (*n*= 359)	**Current study (*n*=249)**
Infant characteristics	**n (%)**	**n (%)**
First born	118 (32.9)	78 (31.3)
Female/male	154/205 (42.9/57.1)	110/139 (44.2/55.4)
Twin	5 (1.4)	5 (2.0)
Family / household	**n (%)**	**n (%)**
SEIFA Index of Social Disadvantage Quintile[5]		
1	139 (38.7)	88 (35.3)
2	30 (8.4)	19 (7.6)
3	132 (36.8)	100 (40.2)
4	32 (8.9)	23 (9.2)
5	13 (3.6)	9 (3.6)
Household main source of income		
Full time employment	168 (46.8)	125 (50.2)
Part time employment	34 (9.5)	26 (10.4)
Benefit / Pension	150 (41.8)	95 (38.2)
Other (casual, self-employed)	7 (1.9)	3 (1.2)
Current housing problems	62 (17.3)	45 (18.1)
Currently being threatened with eviction	8 (2.2)	4 (1.6)

[1] Measured using the Depression Anxiety Stress Scales (DASS) (Lovibond & Lovibond, 1995)
[2]Anxiety range: normal 0-3, mild 4-5, moderate 6-7, severe 8-9, extremely severe 10+
[3] Depression range: normal 0-4, mild 5-6, moderate 7-10, severe 11-13, extremely severe 14+
[4] Stress range: normal 0-7, mild 8-9, moderate 10-12, severe 13-16, extremely severe 17+
[5] Socioeconomic Index for Areas (SEIFA), lowest scoring 20% of areas receive a decile number of 1 and highest scoring 20% receive a decile number of 5.
n= 227–249 for current study (some missing participant data on one or more variables).

Table II: Detailed description of maternal behaviours (predictor variables)

Maternal behaviour		Definition	Example		Previous studies exploring associations between parental behaviours and child language
			Infant	Adult	
RESPONSIVE					
Verbal imitation		Mother repeats infant vocalisations and words. Imitations of words coded if developmentally and contextually appropriate (Tamis-LeMonda et al., 2001). Allowance made for speech error processes. Can be imitation of real word or non-word vocalisation.	"*Ca*!" whilst holding a cat	"*Cat*!"	Levickis et al., 2014; Masur et al., 2005; Tamis-LeMonda et al., 2001
Responsive[1] Question	'Wh'	Mother asks a "wh" question (e.g. "*what*," "*when*," "*who*"), which is immediate and dependent on the infant's preceding act (Tamis-LeMonda et al., 2001).	Infant reaches in to a bag	"*What's in there?"*	Levickis et al., 2014; Tamis-LeMonda et al., 2001
	Yes/No	Mother asks a question requiring a binary (yes or no) answer which is immediate and dependent on the infant's preceding act.	Infant pushes a toy figure down the slide	"*Is the boy going down the slide?"*	
Label		Mother labels an object or action, which is the focus of the infant, with the label in the final position of the carrier phrase (Levickis et al., 2014)	Infant picks up a toy horse	*"It's a horse!"*	Della Corte, Benedict, & Klein, 1983; Levickis et al., 2014

Maternal behaviour		Definition	Example		Previous studies exploring associations between parental behaviours and child language
			Infant	Adult	
INTRUSIVE					
Prohibition		Imperatives used explicitly to try and prevent the infant's current behaviour or vocalisation (Della Corte et al., 1983). Excluded commands related to infant or sibling safety.	Infant mouths a toy	*"Don't eat it!"*	Della Corte et al., 1983; Hart & Risley, 1995
Redirective[2]	Successful	Mother uses a command to successfully move the infant's visual or physical attention from their current activity to one of the mother's choosing.	Infant playing with toy playground	*"Look at the blocks!"* Infant shifts attention to mother.	Masur et al., 2005; Shimpi & Huttenlocher, 2007;
	Unsuccessful	Mother uses a command which is unsuccessful at moving the infant's attention from their current activity to one of the mother's choosing.	Infant is playing with the playground	*"Look at the blocks"*. Infant does not acknowledge command.	

[1] Divided in to open-ended and closed questions as there may be variation in the learning benefit of different question types depending on encouragement of child participation, choice-making and problem-solving. [2] Directives are inconsistently associated with child language outcomes (Lloyd & Masur, 2014) and may depend on whether they are successful or unsuccessful in shifting the child's attention (Shimpi & Huttenlocher, 2007)

Table III: Detailed descriptions of infant communication behaviours (outcome variables)

Infant behaviour	Definition	Example	Previous research
Look to face	Coded each time an infant gazes towards their mother's face. Measured frequency of gazes over five minutes.	Infant playing with a toy and looks up to mother and smiles.	Fogel, Dedo, & McEwen, 1992
Pretend play	Coded for each action with an object, pretending to be a parent or imitating adult actions. Pretend play could be spontaneous or imitated (Fenson et al., 1994).	Infant picks up a toy horse and makes it gallop (one code). Horse put down and then picked up again and gallop repeated (one code) (counted as two instances of pretend play in total).	Laakso Poikkeus, Katajamäki, & Lyytinen, 1999
Vocalisations	Vocalisations were counted using a time-sampling procedure whereby the infant was observed over 15s intervals; one mark was awarded if the infant vocalised during each interval (see Goodwyn, Acredolo, & Brown, 2000). For every 15s period in which the infant exhibited the criterion behaviour at least once, they received a tally mark (maximum score of 20).	Infant making noises to themselves whilst playing with toys.	Alston & St James-Roberts, 2005; Goodwyn et al., 2000; Laakso et al., 1999
Total words	Measure of cumulative words spoken over the five-minute video. Due to the idiosyncrasy of early words, six criteria were used to differentiate vocalisations from lexical items (see Furey, 2011), for example, the word matched the adult target or was treated meaningfully by the mother.	Infant pushing the toy figuring down the slide and saying *"ga!"* and mother repeating *"go!"*.	Furey, 2011; Shimpi et al., 2012
Unique words	Measure of different words spoken by the infant. Subtracted duplicated words from measure of total words.	Infant saying *"more"* after each game of peek-a-boo with mother, played three times. 'More' only counted as one unique word.	Hoff-Ginsberg, 1998

Infant behaviour	Definition	Example	Previous research
Point	Coded each time an infant extends their index finger and arm towards an object/person (Cameron-Faulkner, Theakston, Lieven, & Tomasello, 2015).	Infant points to an object which is out of reach.	Cameron-Faulkner et al, 2015
Give/show	Coded each time an infant places an object in the proximity of the mother, either in the mother's hand, in her lap or on the floor in front of the mother (give) (Cameron-Faulkner et al., 2015). Also includes deliberate extension of an object towards the mother without being relinquished (show).	Infant struggling to put a block on top of a tower so hands the block to their mother for help.	Cameron-Faulkner et al., 2015

Table IV: Fluency and connectedness scale with anchor behaviours (modified from Adamson et al., 2012; Hirsh-Pasek et al., 2015)

Item	**Anchors**						
	1=	2=	3=	4=	5=	6=	7=
Fluency & connectedness of conversation: characterises the flow of the conversation	No conversation established	Some fleeting verbal/non-verbal exchanges	Instances of child initiating and mother responding	Conversation lacks smoothness, appears to be largely dominated by one partner	Shared topic throughout. Both partners engaged in relatively equal turn-taking	Extension of interaction and play from both mother and child	Fluid and balanced conversation that is often sustained

Table V: Correlation matrix of maternal behaviours (predictor variables) and infant behaviours (outcome variables)

	Maternal behaviours (predictor variables)						
Infant behaviours (outcome variables)	Imitation	Responsive question	Yes / No question	Label	Prohibition	Successful redirective	Unsuccessful redirective
Look to face	0.22**	0.18**	0.11	0.13*	0.00	0.03	-0.05
Pretend play	0.12	0.02	0.11	0.05	-0.01	-0.07	-0.10
Vocalise	0.27**	-0.03	0.02	0.04	0.02	-0.05	-0.04
Total words	0.56**	0.10	0.04	0.12	0.06	0.01	0.00
Unique words	0.43**	0.08	0.05	0.11	0.04	-0.03	0.04
Point	0.04	-0.05	-0.03	0.01	0.01	0.00	-0.04
Give/show	0.24**	0.02	-0.04	0.05	0.01	0.02	-0.07

*p ≤0.05, **p ≤0.01

Table VI: Adjusted associations[1] between significant maternal behaviours (predictor variables) and infant communication (outcome variables)

	Maternal behaviour (rate/min)					
	Imitation		Responsive question		Label	
Infant communication (rate/min)	Co-efficient [95% CI]	R^2 %	Co-efficient [95% CI]	R^2 %	Co-efficient [95% CI]	R^2 %
Look to face	0.01 [-0.03, 0.30]	12	0.01 [-0.05, 0.27]	11	0. 06 [-0.13, 0.24]	11
Vocalisation	0.20* [0.07, 0.33]	9	-	-	-	-
Total words	0.59** [0.37, 0.82]	41	-	-	-	-
Unique words	0.57** [0.36, 0.77]	20	-	-	-	-
Give/show	0.18 [-0.07, 0.42]	6	-	-	-	-

Note: Only significant correlations between maternal and infant behaviours were explored in the regression models.
[1] Figures adjusted for potential confounders including age at assessment, gender, maternal education, birth order, main language, family history of language and literacy difficulties, *p=≤.05, **p ≤.001, all adjusted $R^{2,}$
- = correlations which were not significant.

Table VII: Three-way interaction between maternal behaviours, predicted infant communication outcomes and the fluency and connectedness of the interaction

Predictor variables held at	Imitations and vocalisations	Imitations and total words	Imitations and unique words
	Co-efficient [95% CI]	Co-efficient [95% CI]	Co-efficient [95% CI]
Fluency and connectedness = 1	-.05 [-.32, .21]	.11 [-.27, .48]	.14 [-.28, .56]
Fluency and connectedness = 2	.05 [-.13, .23]	.30* [.04, .57]	.31* [.03, .58]
Fluency and connectedness = 3	.16* [.03, .28]	.50** [.29, .71]	.48** [.29, .66]
Fluency and connectedness = 4	.26** [.11, .41]	.69** [.45, .93]	.64** [.42, .86]
Fluency and connectedness = 5	.37** [.14, .59]	.89** [.55, 1.22]	.81**[.46, 1.16]

*p=≤.05, **p ≤.001